National Institute of Environmental Health Sciences

Mapping the Science: Visualizing Bisphenol A (BPA) Research Using NIH Topic Maps

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Abstract

One of NIEHS' strategies for the American Recovery and Reinvestment Act (ARRA) funding of 2009 was to make larger investments in a small number of defined research areas. An ARRA "Signature Project" formalized a research consortium for grantees working on Bisphenol A (BPA). In 2013, NIEHS conducted an exploratory analysis using the NIH Maps tool to understand if new "constellations" of inquiry emerged on the map of NIH science after ARRA investments in the portfolio. We analyzed the application titles and abstracts of the BPA grantees, and compared them to publication titles and abstracts, overlaying both on the existing map of NIH funded research grants. The grantees completed their work in 2012, only a year prior, so this was an early look at the influence of the ARRA funding. However, preliminary results suggest that while key words from applications cluster tightly on the NIH map, key words from publications are more broadly distributed. This confirms our expectations that publications would address a wider array of topics than a grant proposal and introduces the possibility that the consortium influenced the direction of the science. Results also suggest that when examining publications resulting from ARRA-funding, the ARRA funding did help move the field in new directions. It is our hope that the NIEHS leadership and program staff will be able to use this type of analysis to view the evolution of science over time.

Introduction

The main goal of the analysis was to gain an understanding of our BPA portfolio using a novel visual analysis technique. We did so using the publically available NIH Topic Map using a method called "topic modeling". The tool is available on the NIH public Website.

Key Evaluation Questions:

1. Understand the location of the NIEHS BPA portfolio on the map. (Figure 2)
2. Examine the publications that resulted from these grants using the same spatial backdrop. (Figure 3)
3. Explore portfolio by funding source (ARRA/Non-ARRA). (Figure 4)

Materials and Methods: NIH Topic Maps

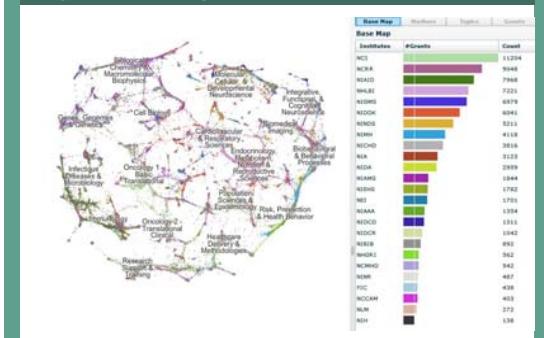
The NIH Topic Map tool* provides a visual display of all NIH grants at a given time. Each grant is represented by a point. The position of each point is calculated by an algorithm that analyzes the words in the titles, abstracts and specific aims of the grants and translates that into a geographic proximity. The closer points are, the more closely related they are in terms of their word content.

After creating base map of all grants active on 9/27/2013 (Figure 1), we:

1) Identified and plotted the 43 grants in the NIEHS Bisphenol A (BPA) grant portfolio. (Figure 2)
2) Identified and plotted publications from those grants using the same NIH map algorithm. (Figure 3)
3) Examined the BPA portfolio publications by ARRA or non-ARRA funding source. (Figure 4)

*The NIH Topic Map tool development was led by Dr. Edmund Talley in the National Institute for Neurological Disorders and Stroke (NINDS).

Figure 1: NIH Map Viewer



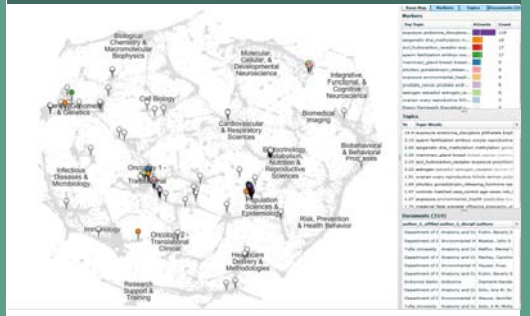
This is a base map of NIH grants (approximately 80,000) active on 9/27/2013. Each NIH IC/O is represented by a different color, shown in the key to the right. "Count" refers to the number of grants funded by each IC/O. Labels on this map are automatically generated by the tool. They provide a general scientific classification of the grants located in close proximity to the label.

Figure 2: NIEHS BPA Grants 1996-2010

The 43 NIEHS BPA grants are plotted on the NIH Base map from Figure 1 (Green pins). The majority of grants co-locate near the population science/epidemiology cluster, with a few in other clusters such as training, oncology and basic translational research. The map provides an immediate visual classification of the type of science happening in the grants.

Conclusion: This result matched our expectations based on our understanding of the portfolio.

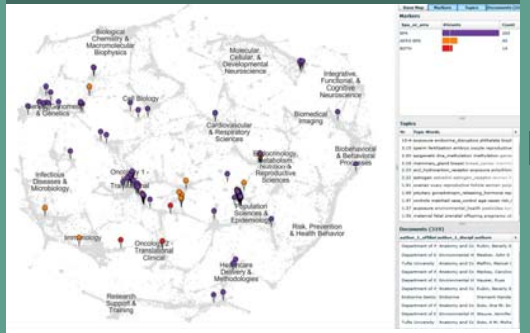
Figure 3: NIEHS BPA Publications, 1990-2012



Publications (N=319) produced by the NIEHS BPA grant portfolio, which includes publications resulting from grants in the traditionally funded and ARRA funded portfolio, were then plotted. Publications are more spread out on the map compared to the grants. There are still many co-located in the population sciences/ epidemiology cluster, and an increase in the oncology 1/translational cluster. We also see new clusters in neuroscience, gene/genomics/genetics, cell biology and endocrinology.

Conclusion: Research findings from the grants cover more topics than the original grant abstracts and provide an indication of key science directions of the portfolio.

Figure 4: Publications by Funding Source



Here, the colors represent the funding source of the grant that produced the publication. Purple represents publications from non-ARRA funded grants, orange represents publications from ARRA-funded grants and the red represents publications from grants supported from both ARRA and non ARRA funds.

Conclusion: The clustering of red and orange pins in new areas suggests ARRA funding did help move the field in new directions.

Discussion of the NIH Map Tool

Strengths

- Visual picture helps us see patterns in the data.
- Automated algorithm processes data quickly.
- Tool is agnostic and can be used on any platform (e.g.: PC, Mac).
- Tool is technically simple and easy to use.
- The color coding is flexible and easy to change.
- Using the tool, we have the ability to show changes over time.

Weaknesses:

- Data cleaning requirements are high and time consuming.
- Manual review was needed in pilot project to confirm that display locations for grants and publications made sense.
- Automated algorithms have difficulty distinguishing meaning, e.g., "Lead" vs. "Pb".
- A novel and potentially robust form of analysis but we struggle with how to best obtain meaning from the results.

Future Directions

- Can the NIH Topic Map Tool help IC's understand the contribution of a portfolio compared to all research funded at NIH? Helps answer: What is our "added value"/niche?
- Examine how does our BPA portfolio compare with our portfolios focused on other exposures? For example, did we fund more/fewer BPA grants than other exposures?
- Cluster NIEHS grants by disease/end-point.
- Use NIH Topic Map tool to identify areas of common interest and potential collaboration with other IC/Os.
- Network analysis of the NIEHS BPA Portfolio.

References

1. NIH Topic Map Viewer. (2014) . Web-based application software. Retrieved from: http://www.nihmaps.org/index.php
2. Ruben, E., Pettibone, K., Drew, C. (2013, October). Mapping the Science: Using Visualization Tools to Examine Research Topics. Presentation conducted at the American Evaluation Association conference, Washington, DC.
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Acknowledgments

This work is funded by the National Institute of Environmental Health Sciences.

Special thanks to Ned Talley and Miriam Leenders, National Institute of Neurological Disorders and Stroke for their help with the NIH Topic Maps.